15.3

The SPoRT-WRF: Evaluating the Impact of NASA Datasets on Convective Forecasts

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Presentation Outline

Introduction/Motivation

SPoRT-WRF Version 1 Overview and Procedure

SPoRT-WRF Version 1 Quantitative and Qualitative Results

Feedback on SPoRT-WRF Version 1 at 2011 HWT EFP

SPoRT-WRF Version 2 Development

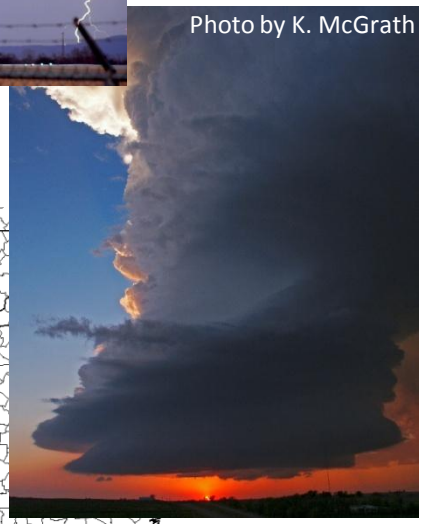
Summary

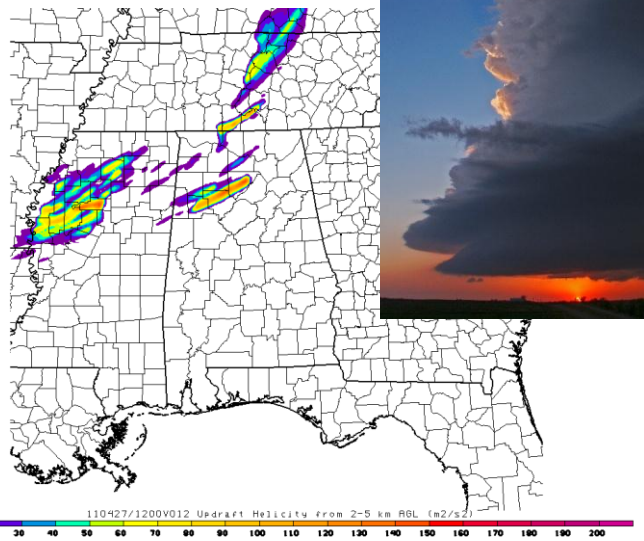
Photo by K. McGrath

Photo by K. McGrath

Introduction/Motivation

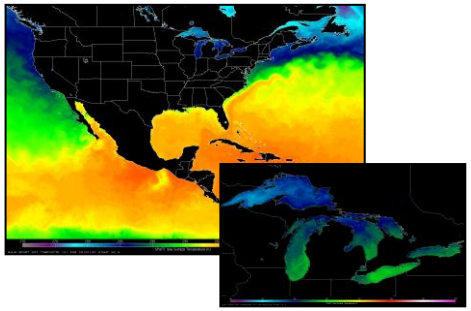
- SPoRT focuses on improvements to short-term, regional weather forecasts using unique NASA products and capabilities
- Accurate forecasting of convection (timing, intensity, mode, location) is forecast challenge for regional/local scale modeling
  - WFOs cite this as main forecast challenge in their local modeling efforts
  - SPC/NSSL have revolved their Spring Experiment around the "convection-in-models" forecast challenge for many years
  - SPoRT's data sets provide additional information on factors that contribute to convection in NWP models
- Since SPoRT's inception, research projects have examined the sensitivity of a individual dataset or capability
- SPoRT-WRF combines all datasets and capabilities into one real-time modeling system for testbed evaluation by forecasters



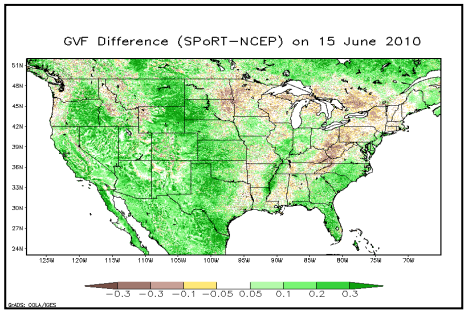


SPoRT-WRF V1 Background

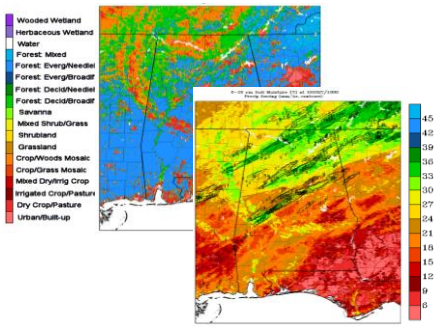
- Identical configuration to National Severe Storms Laboratory (NSSL) WRF used operationally by SPC
  - Same WRF core (ARW), domain (CONUS), resolution (4-km), and physics options (convective allowing)
  - Except for 12-km NAM-218 used for initial and boundary conditions
- NASA Unified WRF (NU-WRF) with unique NASA datasets and capabilities:



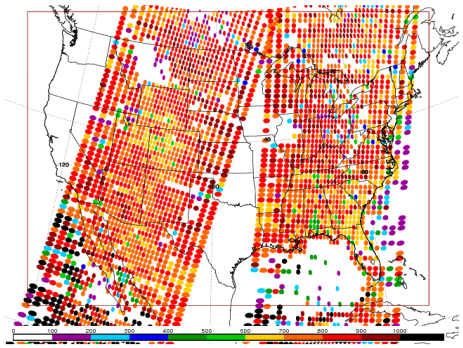
- SPoRT SST Composite
  - 2-km resolution
  - Generated twice daily
  - Provides details that allow model to account for over-ocean fluxes and seabreeze forecasting



- MODIS GVFs
  - 1-km resolution
  - Generated once daily
  - Replaces coarse climatology to produce weather-of-the-day details that affect energy fluxes for weakly-forced convection



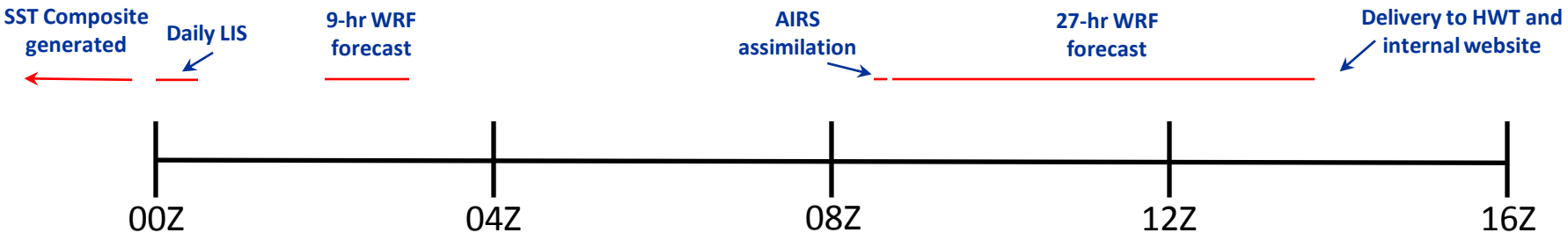
- LIS
  - 3-km resolution
  - Run once daily (available every 3 hours)
  - Uses precipitation data and vegetation to predict soil characteristics that shape energy fluxes for weakly-forced convection



- AIRS Profile Assimilation
  - 45-km resolution
  - Assimilated once days (available twice daily)
  - Enhances upper-air analysis at asynoptic times to provide information on atmospheric moisture and stability

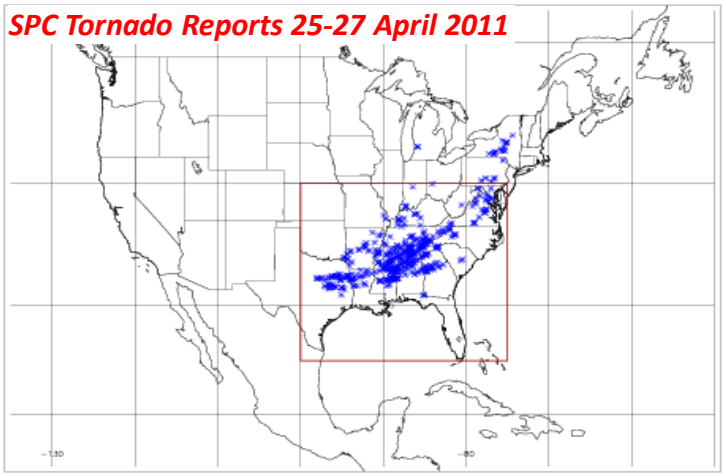
SPoRT-WRF V1 Procedure

- Initialized each day at 0000 UTC
- Surface datasets integrated into SPoRT-WRF at initialization using a modified version of the NU-WRF Preprocessing System (WPS)
  - MODIS GVFs are incorporated into the system through the LIS
  - LIS is run offline once per day to provide land-surface information for model
  - SPoRT SSTs are generated offline and brought in as a replacement for the RTG SST product
- AIRS profiles assimilated using WRF-Var with 9-h forecast as background
- Forecast runs additional 27 hours (total of 36) producing forecast output every hour
- Files are postprocessed using the WRF Postprocessor (WPP) with GRIB1 files sent to HWT and model output images displayed on internal SPoRT website

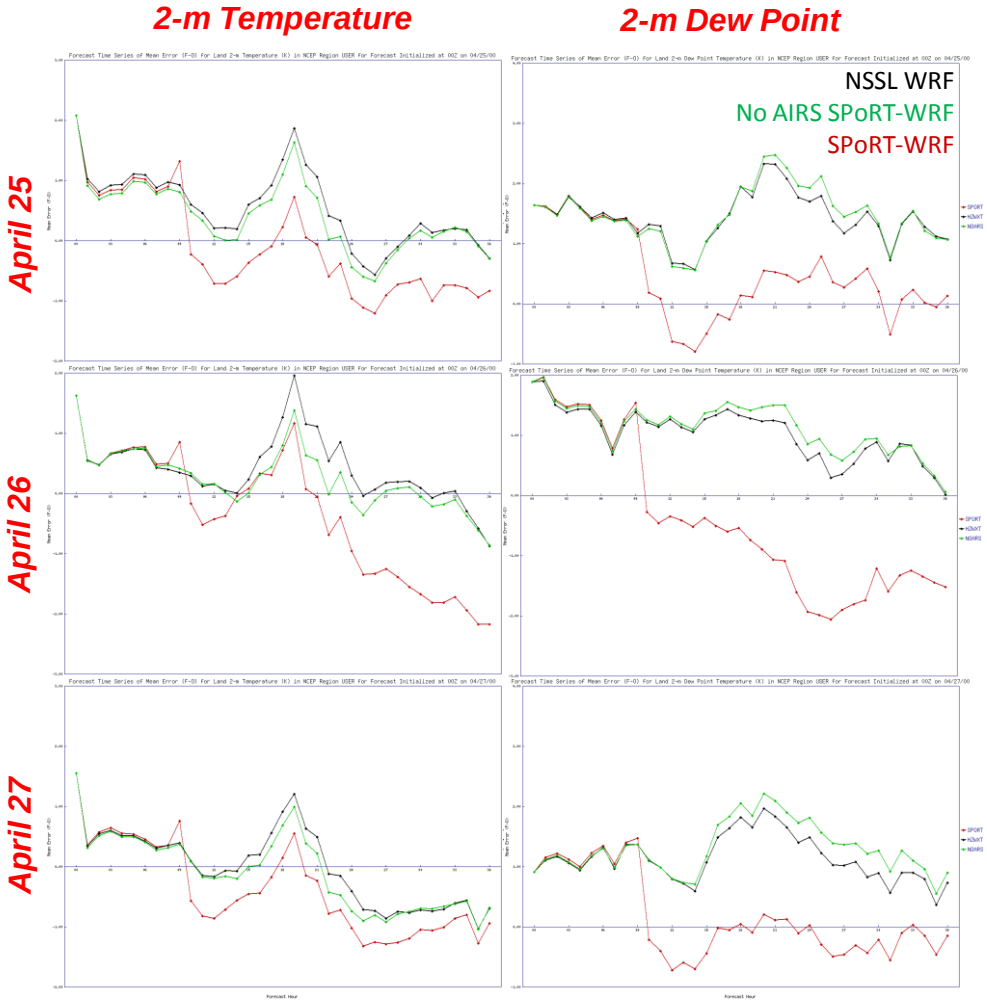


Current Daily SPoRT-WRF Timeline

Impact on April 25-27 Forecasts



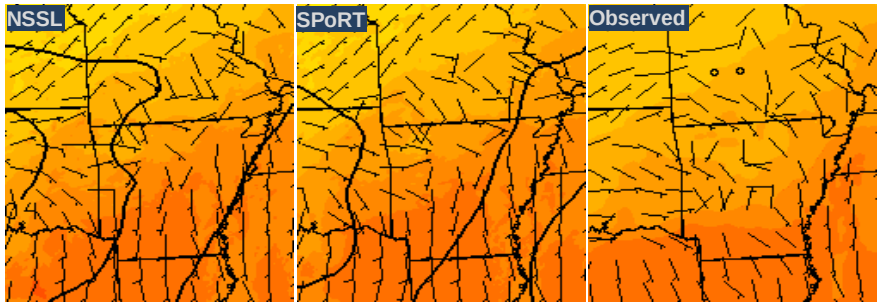
- MET evaluation tools used to produce a statistical evaluation of surface characteristics comparing SPoRT-WRF to NSSL-WRF for historic tornado outbreak
- ***Conclusion***: SPoRT-WRF tends to be have a cool and dry bias for 2-m T and T_d
  - Largest impact from AIRS profiles
  - LIS/GVFs slightly cool and moisten
  - Likely little impact from SSTs for these strongly-forced non-coastal storms



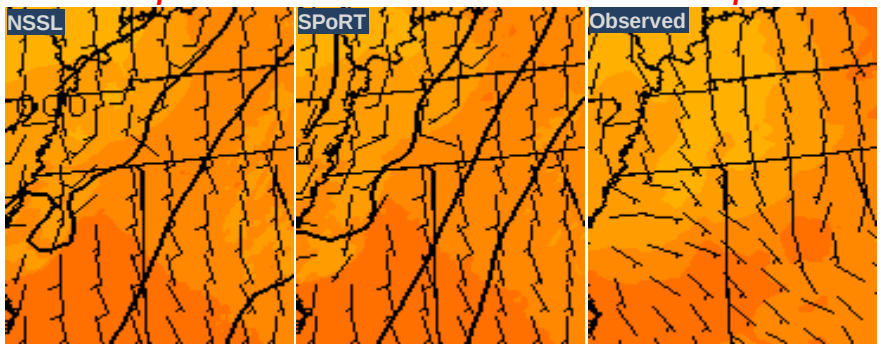
Mean Forecast Error (F-O) Compared to METAR, SAO, and Mesonet Observations

Qualitative Forecast Comparison

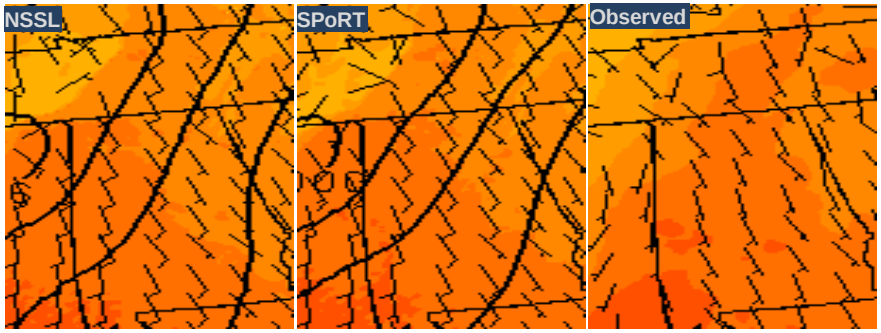
2-m Temperature and 10-m Winds at 0900 UTC 25 April 2011



2-m Temperature and 10-m Winds at 0900 UTC 26 April 2011



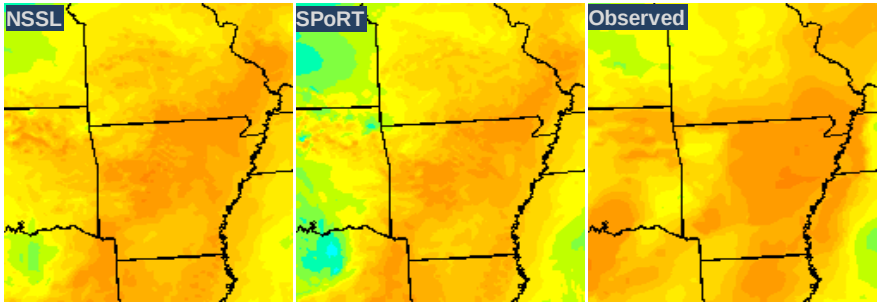
2-m Temperature and 10-m Winds at 0900 UTC 27 April 2011



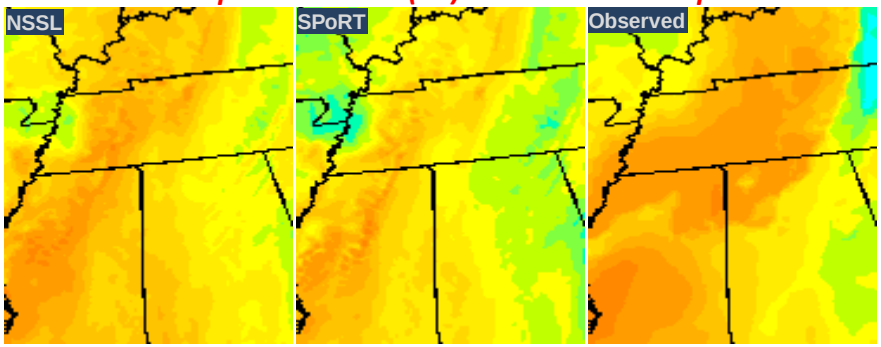
- Evaluated reflectivity at selected forecasts for historic 25-27 April 2011 tornado outbreak across the SEUS
- Tracked reflectivity differences back to initial conditions in surface parameters
- ***Conclusions***:
  - 25 April: SPoRT has slightly cooler 2m temperature than NSSL, but is more consistent with RUC analysis
  - 26 April: SPoRT has very small differences in 2m temperature from NSSL; both are slightly warmer than the RUC
  - 27 April: SPoRT slightly warmer than NSSL; RUC analysis is cooler than both; SPoRT similar to NSSL for 10m wind; both forecasts stronger southerly winds than RUC

Qualitative Forecast Comparison

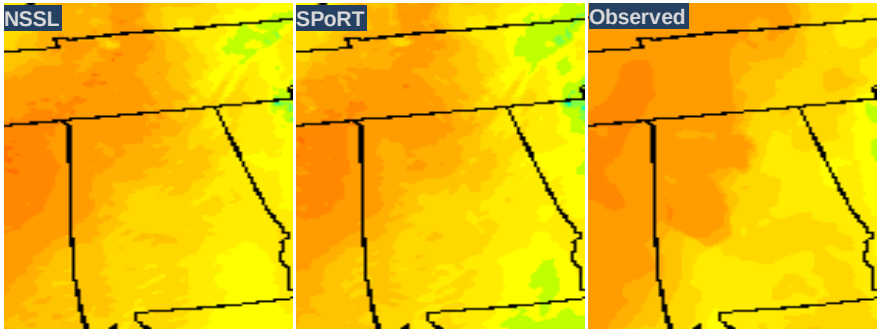
Total Precipitable Water (in.) at 0900 UTC 25 April 2011



Total Precipitable Water (in.) at 0900 UTC 26 April 2011



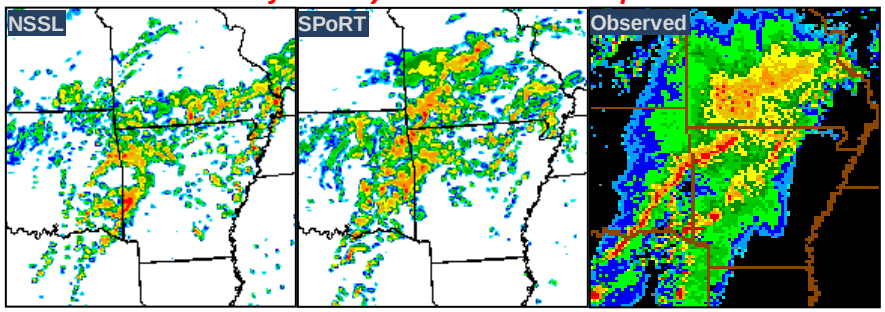
Total Precipitable Water (in.) at 0900 UTC 27 April 2011



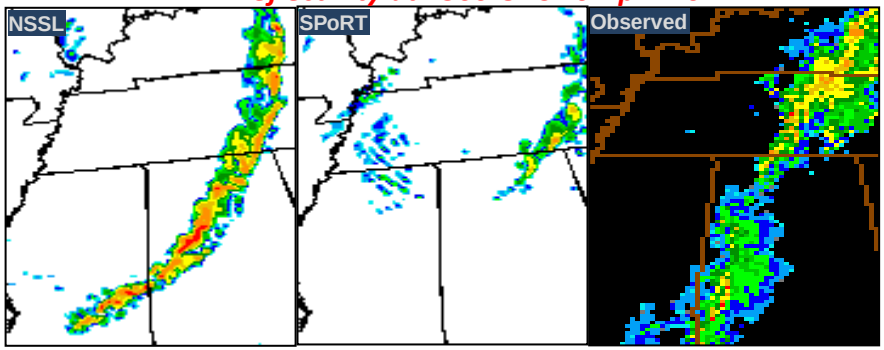
- Evaluated reflectivity at selected forecasts for historic 25-27 April 2011 tornado outbreak across the SEUS
- Tracked reflectivity differences back to initial conditions in surface parameters
- ***Conclusions***:
  - 25 April: SPoRT is drier than NSSL and RUC analysis
  - 26 April: SPoRT is drier than NSSL; RUC analysis is much more moist over N MS and W TN and drier over E TN and E KY
  - 27 April: SPoRT is slightly drier than NSSL; both are drier than RUC analysis

Qualitative Forecast Comparison

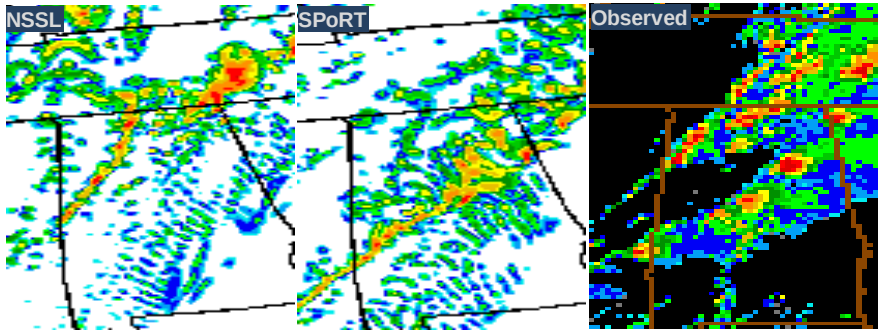
1-km Reflectivity at 2100 UTC 25 April 2011



1-km Reflectivity at 1500 UTC 26 April 2011



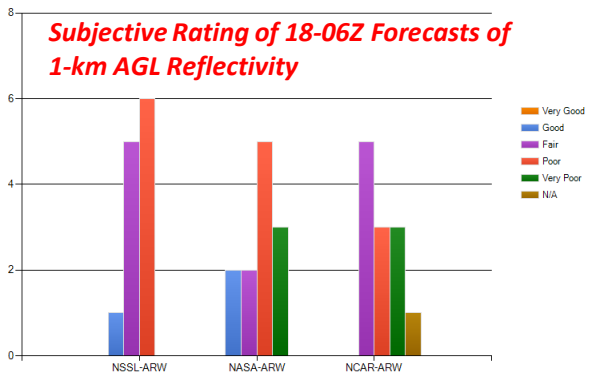
1-km Reflectivity at 0000 UTC 28 April 2011

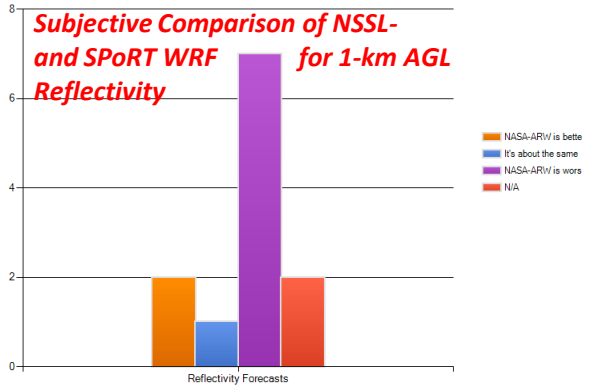


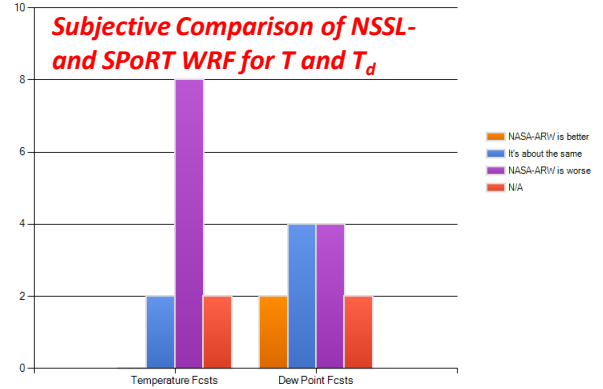
- Evaluated reflectivity at selected forecasts for historic 25-27 April 2011 tornado outbreak across the SEUS
- Tracked reflectivity differences back to initial conditions in surface parameters
- ***Conclusions***:
  - 25 April: SPoRT has more convection with two-band feature in AR/OK/MS tri-state area; more closely matches the observed reflectivity than NSSL
  - 26 April: SPoRT removes almost all precipitation from MS and AL with some convection over NE TN; NSSL produces strong squall line from E KY to E MS; observed reflectivity show precipitation but no convection
  - 27 April: SPoRT displaces cold front too far SE compared to both NSSL and observed reflectivity

Feedback from Spring Experiment

- NOAA HWT's Spring Experiment ran from 9 May – 10 June 2011
  - This year's EFP focused on severe weather, QPF, and CI forecasting
  - Brings together modelers and operational forecasters to subjectively evaluate model performance and discuss the strengths and limitations of regional models and how they should be used operationally
- Each day, participants evaluated a number of regional models
  - SPoRT-WRF was evaluated for 12 days by the severe weather group
  - SPoRT-WRF evaluated against NSSL-WRF and an NCAR-WRF
- Overall feedback was that the SPoRT-WRF was too cool and dry and suppressed convection (some good; some bad)
  - Similar tendency to 25-27 April evaluation
- SPoRT-WRF performed comparably to NCAR-WRF and worse than the NSSL-WRF

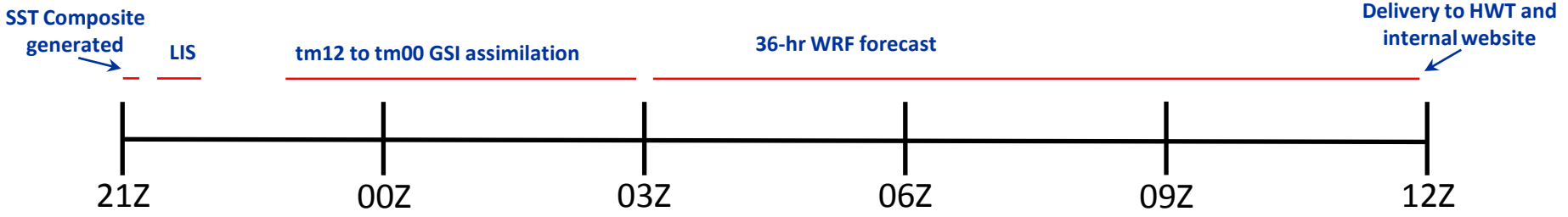






SPoRT-WRF V2

- Feedback from research, testbed activities, and operational users improve model
  - AIRS profiles being assimilated in a start/stop methodology results in "shock to the system" imbalances that are never totally corrected
- Development of Version 2 of the SPoRT-WRF is completed for dissemination to 2012 EFP
  - Continuous (cycling) assimilation using Gridpoint Statistical Interpolation (GSI) with AIRS and IASI thermodynamic profiles, conventional, and other satellite radiances
  - Initialization of LIS during each cycle with improved precipitation forcing using CMORPH climatology product
  - Integration of USGS eMODIS GVF product
- Science questions to be pursued in 2012:
  - What impacts do the NASA datasets and model options have on convective forecasts?
  - How well does the SPoRT-WRF perform (both qualitatively and quantitatively) against other operational models?
  - Which individual components of the SPoRT-WRF have the largest impact on the performance?



Planned 00Z Initialized SPoRT-WRF Timeline

Summary

- SPoRT seeks to improve short-term, regional weather forecasts using unique NASA products and capabilities
- SPoRT has developed a unique, real-time configuration of the NASA Unified WRF (ARW) that integrates all SPoRT modeling research data
  - 2-km SPoRT SST Composite
  - 3-km LIS with 1-km GVFs
  - 45-km AIRS retrieved profiles
- Transitioned this real-time forecast to NOAA's HWT as deterministic model at EFP
- Feedback from forecasters/participants and internal evaluation of SPoRT-WRF shows a cool, dry bias that appears to suppress convection likely related to methodology for assimilation of AIRS profiles
- Version 2 of the SPoRT-WRF will premier at the 2012 EFP and include NASA physics, cycling data assimilation methodology, better coverage of precipitation forcing, and new GVFs